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(12) # EUROPEAN PATENT APPLICATION

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(54) **Curing apparatus.**

(57) Apparatus for curing photo-developing inks printed on sheet material, comprising a main housing, a sheet material conveyor (2) passing through said housing, a line source (5) of ultra-violet light in the housing with the line of said source extending laterally across the conveyor, and reflector means (6) to reflect ultra-violet rays from the light source onto the conveyor (2) in which the reflector means (6) has at least one passageway therethrough for carrying water with the at least one passageway taking up a substantial volume of the reflector.

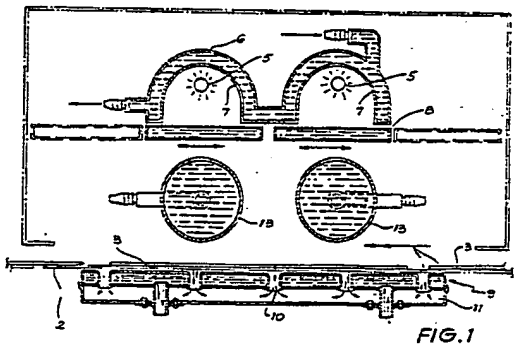

FIG.1

EP 0 146 998 A1

This invention has application to the printing industry and in particular provides means for curing what is referred to in the printing trade as photo-developing inks, or more commonly ultra-violet inks. Such inks by the application of ultra-voilet rays cure into a finished "dried" condition.

In this field it is already known to provide a line light-source of high intensity which is commonly a mercury tube giving off both infra-red and ultra-voilet rays. As a printed sheet or web is passed below the line source it is scanned by the line light-source and the rays emitted from the light-source cure (dry) the ink onto the base material.

Because mercury lamps (tubes) have the desired ray emission they are preferred to other sources ultra-violet rays. Mercury lamps however operate at a temperature exceeding 450^{o}C and when they are operating there is a great deal of heat generated. This heat is a problem in the curing of ultra-violet inks because of the detrimental effect such heat has on the base material onto which the printed image has been deposted. Sheet stock material will curl due to heat and if not passed beneath the lamp at an appropriate rate, scorching, charring and even fire can result from the sheet stock being overheated.

Early developments tried to overcome the heat problem by providing a high speed continuous feed. An early arrangement comprised one or more mercury tubes each with a reflector which partially surrounded the lamp at the side remote from the printed material. The printed material was therefore subject to both direct and reflected radiation. The

reflected radiation was concentrated by the reflector to give a narrow band of high intensity radiation at a set distance from the light-source. With this apparatus it was imperative that the printed material was maintained mobile and travelled at a speed which did not allow it to reach ignition temperature. This arrangement cured all common ink thicknesses. The problem with this arrangement was the maintenance of the desired feed rate. With high speed feed as used, momentary slow down or a feeding jam resulted in burned, ruined product.

A number of attempts have been made to overcome the heat problem. The attempts have been aimed at reducing the heat output of the lamp whilst at the same time retaining the ultra-violet ray intensity of the lamp. The former has been considered as detrimental to ink curing whilst the latter is essential to the curing process.

One such attempt involved a light source housed within a reflector (as before) but the path of all direct and reflected rays was blocked by a transparent barrier. The barrier comprised transparent material enclosing a flowing, cooling liquid. By way of example, this could be achieved by locating the light-source in the inner of two concentric transparent tubes and passing water through the annulus therebetween see German Utility Model 7637428. In another form the mouth of the reflector was completely blocked by two side-by-side tubes through which water was passed see U.S. 4000407 or by a rectangular shaped tube which extended across the mouth of the reflector and through which water was passed.

This latter apparatus worked efficiently on thin ink deposits. By thin is meant ink deposits in the order of 5 to 10 microns thick as would be deposited in printing processes known as litho.

The apparatus was totally inadequate for ink thicknesses in the order of 15 to 127 microns which is a quite common ink thickness deposit in the field of screen printing. At best with screen printed work a surface cure of the ink was achieved but no depth of cure was possible. The ink was therefore surface hard but soft underneath.' Extended exposure had no appreciable effect on the depth of cure.

Recognising the shortcomings of the prior art apparatus the present Applicants developed apparatus which enables screen printing ink deposits to be adequately cured. The apparatus is covered by Australian Patent 517,719. However, with this apparatus there were still disadvantages.

With these devices it was necessary that a substantially large fan be employed to remove heat from within the housing, especially when there were feeding jams.

The present invention overcomes these problems by providing a water-cooled reflector and in a preferred embodiment, a water bed adapted to be located below the conveyor, in heat transfer relationship therewith, is provided.

In another embodiment of the present invention a water-cooled shutter can be added to completely block the light-source when required. Further a water-cooled filter as described in Australian Patent 517719 located between the

ultra-violet light-source and the sheet material containing ink to be cured so as to intercept between 5% and 50% of all the direct rays from the ultra-violet source can be added.

Thus the present invention provides only a limited use of small fans to provide cooling of the lamp ends only, there being no use of fans to cool the housing itself and hence eliminating "stock flutter", and providing a versatility of operation not found with existing apparatus.

Further, as a result of the water-cooled reflectors and shutters the curing head can be quite small and can be added to conventional drying systems with minimal additional usage of floor space.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 illustrates a schematic representation of one embodiment of the present invention showing the water cooled components of the present application;

Figs. 2A to 2D illustrate schematically further layouts of embodiments of the present invention;

Fig. 3 illustrates one embodiment of the present invention positioned over a conveyor carrying the printed substrate; and

Fig. 4 illustrates the embodiment of Fig. 3 with the housing open to allow access to the lamps.

As in conventional ultra-violet ink curing apparatus the embodiments of the present invention, as shown in Fig. 1, have ultra-violet lamps 5 located above a conveyor belt 2, upon which are carried the substrates or stock material 3.

However in the present invention, the reflection 6 is water cooled by having a plurality of passages through the reflector, which passageways take up a substantial volume of the reflector or else the reflector 6 are, as shown in Fig. 1, hollow thin walled stainless steel shells, so as to provide the maximum water contact with the skin of the reflector, containing the reflective surface 7, while maintaining structural stability of the reflector 6. To ensure that there is no dead water, internal baffles (not shown) are constructed in the reflector to ensure complete circulation of water across the skin of the reflector 6, containing the reflective surface.

The reflectors 6 are positioned in the conventional way to reflect light from the lamp 5 back onto the substrates 3. There are existing water cooled reflectors, but these are thick aluminium extrusions with only one or two small passageways for the flow of water therethrough. Thus the present invention provides a more efficient water cooled reflector system with the skin of the reflector containing the reflective surface being in almost total contact with the cooling water.

The water cooled reflectors can be individually supplied with cooling water as shown in Fig. 2A or can be connected in tandem as shown in Fig. 1.

Water cooled shutters 8 can also be provided to automatically slide across the open end of the reflector 6 to isolate the lamp 5 from the substrate 3 on the conveyor 2, if the convey stops or if there is a feeder jam. Again,

preferably the shutter 8 is constructed as a hollow thin walled stainless steel shell and is internally baffled along its length to ensure complete circulation of water. Thus when the shutters are closed across the filters there is no appreciable heat radiated from the lamps to the conveyor.

This provides a large improvement over the prior art shutters which were solid metal, and as such when closed, because of heat transfer radiated too much heat to the substrate below.

As shown in Figs. 1 and 2C water cooled filters 13 can be used to regulate the degree of heat directed to the substrate. Suitable filters and their operation are described in Australian Patent 517,719.

Further a water cooled bed 9 can be located beneath the conveyor 2 in heat exchange relationship therewith to further absorb heat from within the housing 4. As shown in Fig. 1 this bed takes the form of a thin walled stainless steel shell suitably baffled to ensure complete circulation of water across the bed. To facilitate cooling of the housing 4, the bed 9 has a chamber 11 with a plurality tubing 10 passing through the water chamber. A vacuum is applied to the chamber 11 drawing air from the housing through the conveyor belt 2, which is of porous or web structure, through the tubing 10, where it is cooled.

Because ozone free lamps are used and the air from the housing is cooled when it passes through the water cooled bed, the air can be exhausted into the work area without causing any significant heat pollution of the work area.

As a result of the water bed also being a vacuum bed, the substrates are held down on the conveyor, offering no chance of stock flutter, also the substrate is subjected to a chill effect with the concentrated heat from above, and heat is removed from the housing and from the exhaust air.

The embodiments of the present invention can be provided in modular configurations as shown in Figs. 2A to 2D.

In Fig. 2A two spaced apart water cooled reflectors are used with two small fans 12 in the housing to provide cooling. In this arrangement the lamps are positioned such that the area of illumination by the direct rays of one lamp do not overlap with the area of illumination by the direct rays of the other lamp.

An embodiment of the present invention as shown in Fig. 2B, is suitable for high speed web printing, using heat sensitive substrates. As a result of the high speeds only the water cooled reflections are required for effective operation with the water cooled shutters being provided in the case of jams.

In Fig. 2C an arrangement is shown for low speed screen printing of heat sensitive substrates using the filters 13 as heat regulators. If the substrates are particularly heat sensitive the water cooled bed could also be used.

In Fig. 2D an arrangemnet is shown suitable for offset sheet high speed printing. In this case there is an area 17 where the light from both lamps overlap to provide an accelerated curing area.

Thus because of its small size, due in part to the water

cooled reflectors, and the modular configuration of the present invention, the embodiments of the present invention can be easily fitted to existing printing lines to satisfy most if not all of the curing conditions generally found in practise.

The cooling water can be supplied directly from the mains or through a chiller or a cooling tower and recirculated.

The ultra-violet light source can be controlled by a ballast to produce a low, medium or high output of 200, 250 or 300 watts/linen inch. As higher output temperatures are becoming more popular with printers, extra cooling by means of chillers or cooling towers will be needed.

The present invention in one embodiment as illustrated in Figs. 3 and 4 comprise a housing 4 having a lid 14 with openings 16 to allow air to be drawn into the housing. The lid can be hinged open as shown to allow the light and reflector housing 15 to be pivoted open (as shown in Fig. 4 to allow ease of access to the lamps and reflectors, for replacement of lamps.

CLAIMS:

1. Apparatus for curing photo-developing inks printed on sheet material, comprising a main housing, a sheet material conveyor passing through said housing, a line source of ultra-violet light in the housing with the line of said source extending laterally across the conveyor, and reflector means to reflect ultra-violet rays from the light source onto the conveyor characterised in that said reflector means 6 has at least one passageway therethrough for carrying water with the at least one passageway taking up a substantial volume of the reflector.

2. Apparatus according to claim 1, characterised in that said relfector means 6 comprises a hollow thin walled metal shell having internal means to ensure substantially complete circulation of water through said reflector.

3. Apparatus according to claim 2, characterised in that said internal means are baffles and said reflector means is made from stainless steel.

4. Apparatus according to any one of claims 1 to 3, characterised in that said line source 4 of ultra-violet rays and said reflector means 6 are located in a support housing 15 which is adapted to pivot out of said main housing 4, to allow access to the line source 5 and the reflector means 6.

5. Apparatus according to any one of the preceeding claims, characterised in that there is further provided a water cooled shutter 8 which is adapted to slide across the mouth of the reflector 6 in the case of stoppage of the conveyor or if there is a feeder jam, to isolate the line source 5 of

ultra-violet light from the conveyor.

6. Apparatus according to claim 5, characterised in that said shutter 8 is a hollow thin walled metal shell having internal means to ensure substantially complete circulation of water through said shutter.

7. Apparatus according to claim 6, characterised in that said internal means are baffles and said shutter is made from stainless steel.

8. Apparatus according to any one of the preceeding claims, characterised in that there is provided a water cooled bed 9 is positioned adjacent the conveyor 2, but remote from the line source 5 of ultra-violet light, in heat exchange relationship with said conveyor 2.

9. Apparatus according to claim 8, characterised in that said water cooled bed 9 has passageways 10 passing therethrough and adapted to connect the surface of the bed to a source of vacuum such that air is drawn through the housing 4 and through the passageways 10 in the water cooled bed 9 before being discharged.

10. Apparatus according to claim 9, characterised in that said water bed 9 comprises a hollow thin walled metal shell having internal baffles to ensure the complete circulation of water therethrough, with said passageways 10 extending transverse to the direction of flow of the water through the bed 9.

11. Apparatus according to any one of the preceeding claims, characterised in that there is provided a transparent heat sink filter 13 for ultra-violet rays, disposed between the

conveyor 2 and the line source 5 of ultra-violet rays, and adapted to filter from 5 to 50% of the direct infra red rays from the line source 5.

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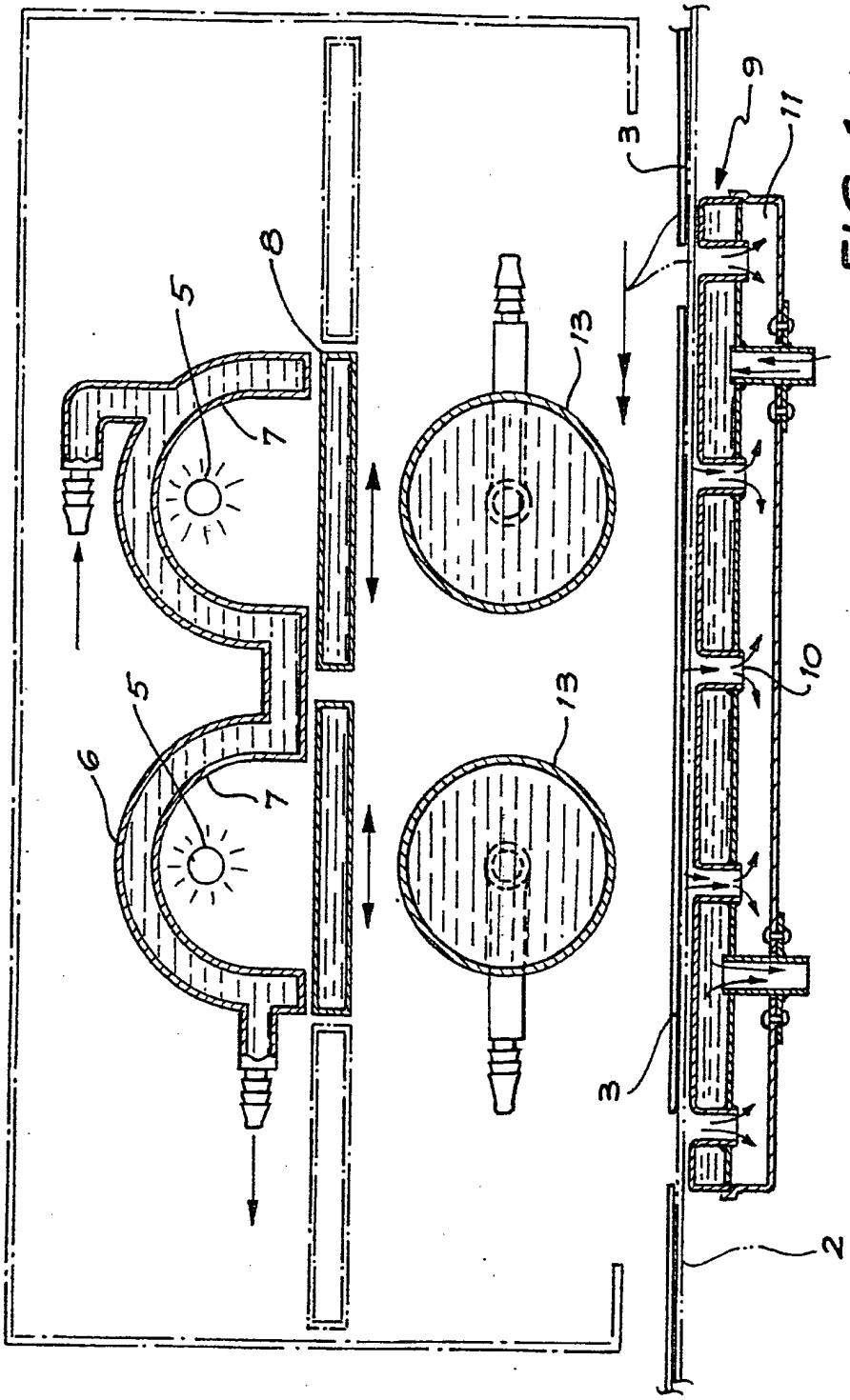

FIG.1

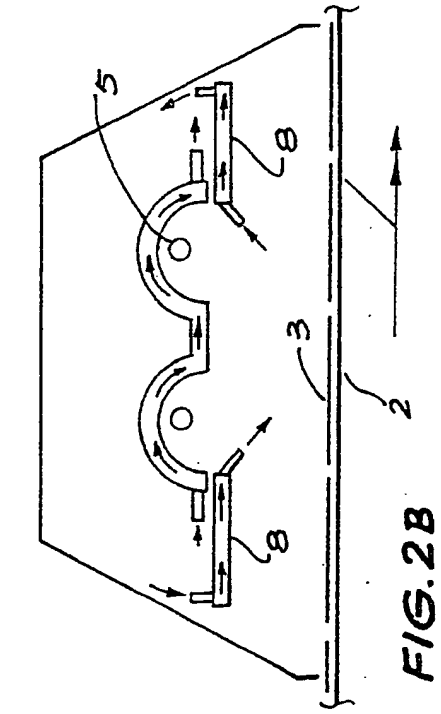

FIG.2B

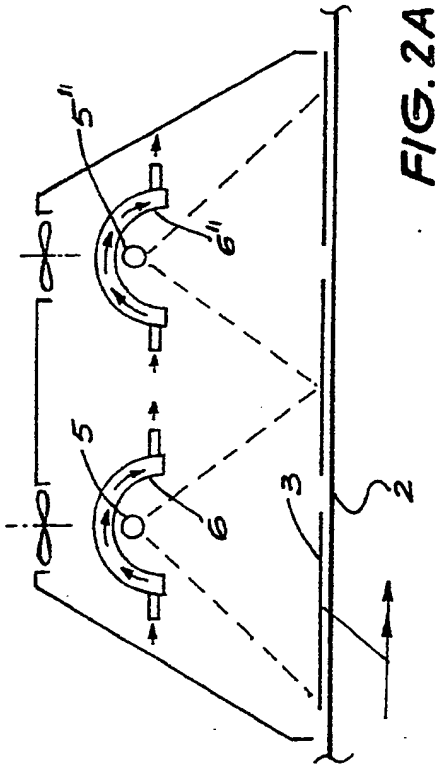

FIG.2A

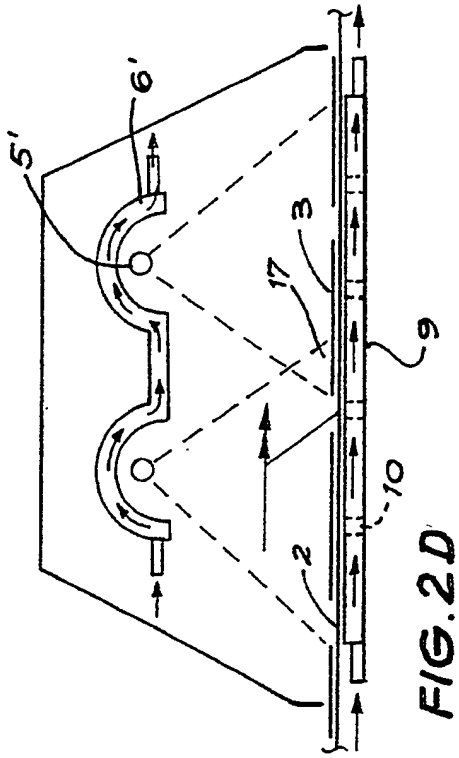

FIG.2D

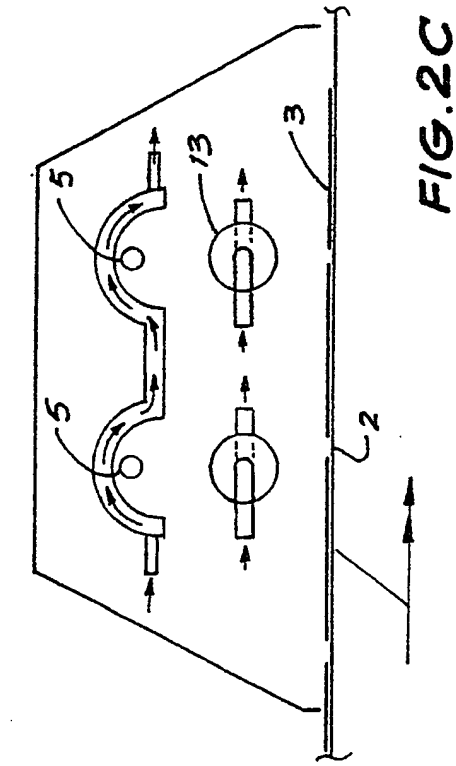

FIG.2C

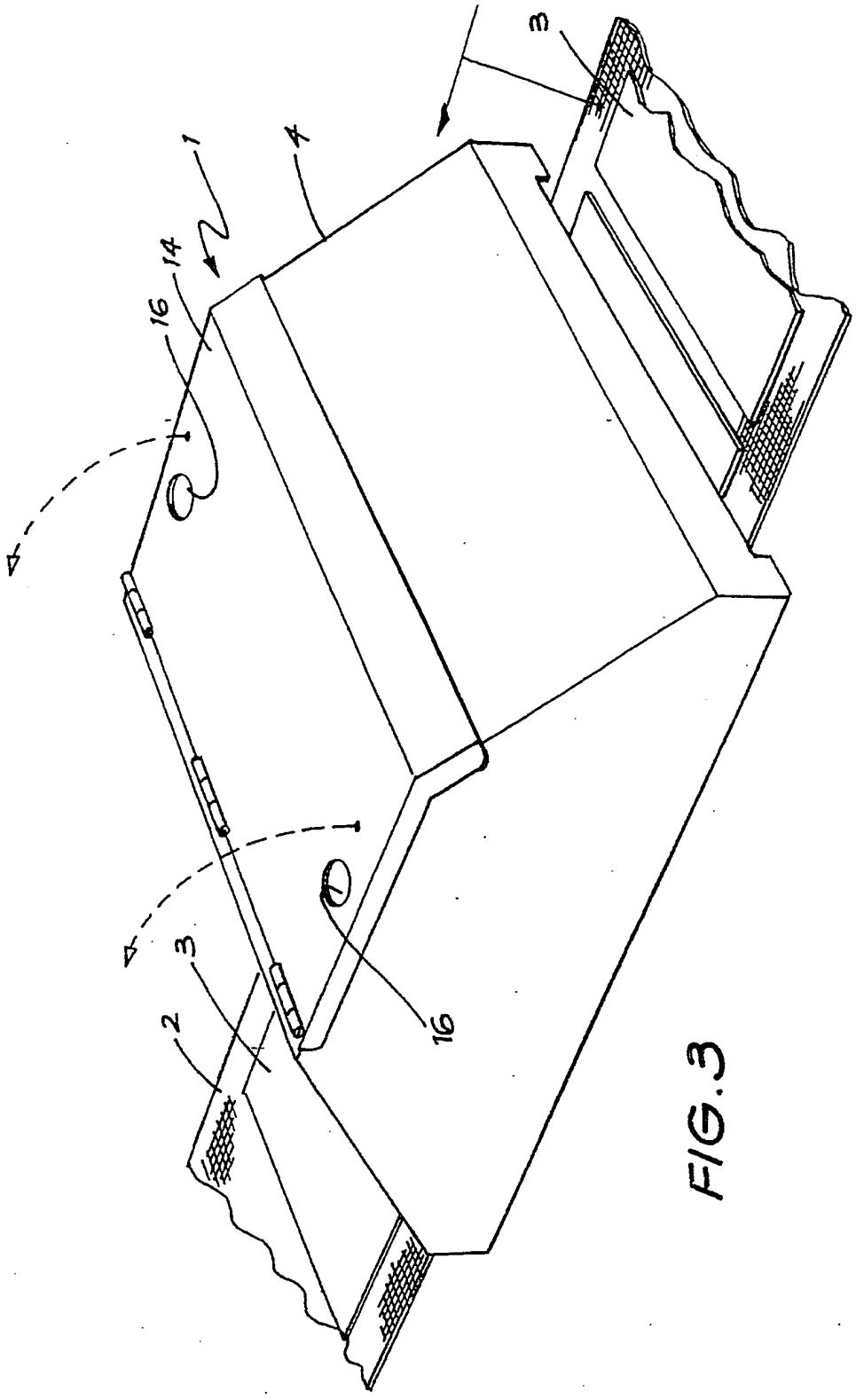

FIG.3

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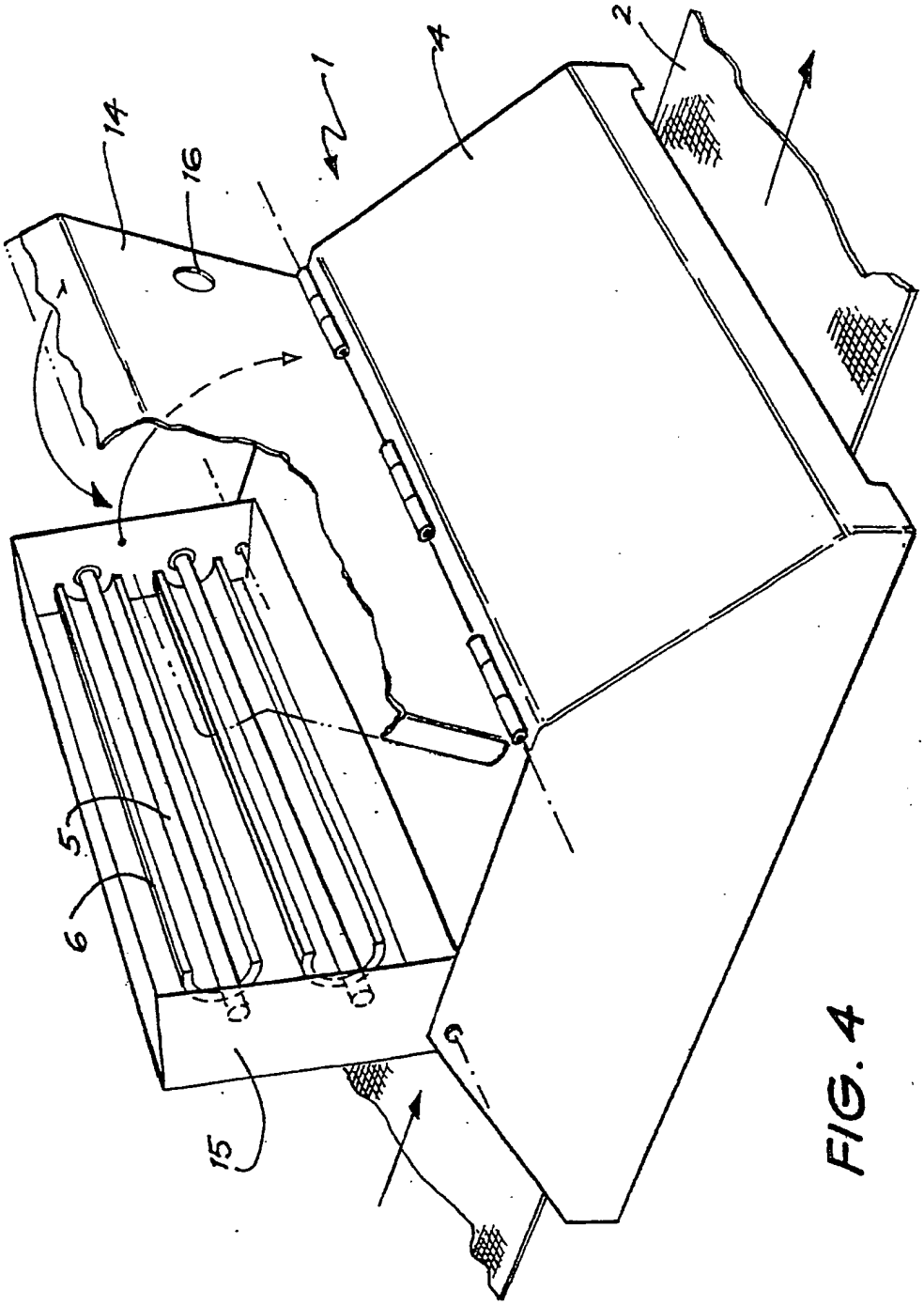

FIG. 4

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Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 84 30 3956

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	GB - A - 1 482 743 (WALLACE KNIGHT) * figure 4; page 2, lines 96-110 *	1,2	B 41 F 23/04 F 21 V 7/20 F 26 B 7/38

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

B 41 F

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	07-09-1984	MÜNKEL

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503. 03.82

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid,

namely claims:

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

1. Claims 1-3: A curing apparatus with a water cooled reflector.
2. Claim 4: A pivotable ultra-violet rays source.
3. Claims 5-7: A water cooled shutter.
4. Claims 8-10: A water cooled bed adjacent conveyor.
5. Claim 11: A heat sink filter

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid,

namely claims:

☒ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims,

namely claims: 1-3